1976 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

Edited by:

Nikki Newcome

1977

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The primary purpose of these reports is presentation of data. Description of programs and data collection methods is included only to the extent required for interpretation of the data. Analysis is generally limited to that necessary for clarification of data collection methods and interpretation of the basic data. No attempt is made in these reports to present analysis of the data relative to its ultimate or intended use.

Data presented in these reports is intended to be final, however, some revisions may occasionally be necessary. Minor revision will be made via errata sheets. Major revisions will be made in the form of revised reports.

1976 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

A summary of data collected from sockeye salmon
(Oncorhynchus nerka) smolt programs on the Kvichak,
Naknek, and Wood Rivers

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1976 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES

By

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INTRODUCTION

Studies aimed at determining the age composition and relative magnitude of sockeye salmon smolt (Oncorhynchus nerka) emigrating from the Iliamna Lake-Lake Clark system have been conducted annually since 1955. Information on smolt production is used for forecasting the age composition and magnitude of subsequent adult returns. Prior to 1973, the primary goal of the program was to determine an index of the smolt outmigration. In 1969, a research and development project was initiated to obtain a total outmigration estimate using sonar equipment. Since 1971, estimates of the total outmigration have been derived as a result of sonar enumeration (Russell 1972; Paulus and McCurdy 1972; Parker 1974a and 1974b).

Operation of the original index program has been continued in conjunction with the sonar total outmigration program although improvements have been made including the use of a more modern sonar aperture counter (Krasnowski, 1975). It is hoped that eventually a relationship can be established between the index and the total outmigration estimate that will permit analysis of historical index data to obtain total outmigration estimates from past years data.

In this report, Age I and Age II are defined as smolt that have spent 1 and 2 winters, respectively, in the freshwater nursery lakes prior to emigration. It should also be noted that the term "total outmigration estimate" is an estimate of the outmigration only for the period sampled. Sampling was conducted from May 15 through June 18, 1976. It is believed that, in general, the bulk of the outmigration occurs between these early spring sampling dates.

1976 INDEX PROGRAM

Materials and Methods

Except for some modernization of the gear, the index program has remained virtually unchanged since the studies began in the middle 1950's. A 4' x 4' fyke net with a sonar aperture counter is fished in a standard location and at a water depth of 3.8 feet. The site is located approximately 2-1/2 miles downstream from the outlet of Iliamna Lake. The sonar counter system consists of two sets of horizontally opposed transducers scanning the 4" by 18" aperture on the downstream end of a funnel attached to the fyke net. The 18° beam angle that the transducers emit provides a combined coverage of approximately 20% of the aperture. Advantages of this equipment over the older type and methods of operation are outlined in Parker (1973b).

When conditions allowed, calibrations of the equipment were con-
ducted to determine whether the counters were functioning within acceptable
limits of the theoretical five fish per count level. The average of
these calibrations was used to expand the aperture counts to estimate
the number of fish passing through the fyke net. Calibration procedures
are described in Krasnowski (1975).

Samples from fyke net catches were used to determine mean lengths
and weights and age composition of the outmigration. To facilitate the
collection of a random sample from the outmigration, the sampling design
included the collection of 300 smolt from each of six 5-day sampling
periods during the season. These smolt were collected 30 at a time from
each of 10 randomly selected hours during the respective 5-day sample
periods. The combined age compositon of the samples, determined from
scales, from each 5-day period was in turn applied to the total
estimated numbers of smolt outmigrating during the same corresponding
period. This sampling design was markedly different from that of previous
years. Previous sampling techniques are described in Randall (1976).

Results

Climatological and Hydrological Observations

Observations of prevailing weather and river conditions were recorded
at the Barge Island field station from May 18 through June 19 (Table 1).
Although air temperatures were about normal for this time of year water
temperatures were the coldest encountered in 4 years of the same
period. Unusually late breakup of lake ice for the second consecutive
year contributed to lowered water temperatures which ranged from 2°C to
9.5°C during the 33 day sampling period with an average of 3.8°C.

Ice conditions on the rivers immediately below the outlet of the
lake were apparently some of the most severe in many years. Ice jammed
the river solidly from the outlet to Kaskanak Flats at 2030 on June 4
and didn't completely break up until 1430 on June 8.

Index Catch

Fishing with the index fyke net commenced on the evening of May 21,
was conducted daily during the traditional index hours of 2200 to 0100
(AST) and was extended every third day to include 24-hours of consecutive
fishing (from 1200 to 1200 the following day). The first day of fishing
on May 21 was also designated as the start of six 5-day periods for
the purpose of analyzing age-weight-length samples.

No fishing of the net was possible on May 26-27 due to heavy ice
flows. Critical hours were missed on other days but small catches
suggested only a minimal outmigration of smolt had occurred prior to the
latter part of the first week of June. From June 4-9, the river was
again blocked with ice which prevented any fishing of the fyke net.

The extended periods of heavy ice flows, coupled with an intentional
shortening of the index fishing schedule, resulted in a total of 139.1
hours of actual fishing out of a possible 273 hours planned for this
season. Since only 51% of the scheduled fishing time was possible this
season, linear interpolations for numerous gaps in the schedule were
required to arrive at a total outmigration index.

The calculated 24-hour index catch for the period 5/21-6/17 is 785,887 smolt (Table 2). Due to late breakup of ice on the lake the timing of the outmigration was considerably later and more intense than normal with over 79% of the catch occurring during a relatively short period from June 10-15. The daily outmigration appeared to drop off drastically following the peak on June 14; however, some outmigration probably occurred after the termination of the program since the daily index catch was 11,500 on the last day of fishing.

Sampling conditions were ideal during the peak catch period from June 10-15 and facilitated the use of the sonar aperture counter on the fyke net. Several calibrations of the sonar unit were conducted during this period to verify that the unit was working properly and to determine an average smolt/count factor for expansion of aperture sonar counts (Table 3). Calibrations ranged from 4.9 to 7.2 with an average of 5.6 smolt per count.

Age-weight-length

A total of 458 smolt was sampled for determination of average age, weight, and length of this year's outmigrants. The estimated age composition of the index outmigration was 98.1% Age I and 1.9 % Age II (calculated from a weighted average of the age composition of catches for six sampling periods during the season.) The mean weight by age class, determined from the length-weight regression formula $W=aL^b$ and a correction term based on the variance of the mean length (Pienaar and Ricker 1968), yielded a mean weight of 5.8 g. for Age I smolt (22 year average = 6.1 g.) and 14.2 g. for Age II smolt (22 year average = 10.9 g.). The mean length by age class for the season was 88.2 mm. for Age I smolt (22 year average = 88.9 mm.) and 120.8 mm. for Age II smolt (22 year average = 110.5 mm.).

1976 TOTAL OUTMIGRATION PROGRAM

Materials and Methods

This year's program included a major modification in previous years' methods of deploying and monitoring the sonar gear used in counting smolt. Modifications in 1976 included a new replacement sonar system consisting of a single Bendix biomass counting unit which is equipped to monitor a system of three transducer arrays (with each array having a total of 14 transducers). Electronic cables from the individual transducers are all connected to this single control unit which was monitored from a location on the east bank. In an effort to minimize the threat of ice damage to the entire system, each array was rigged with an independent cable system anchored to the bottom of the river about 150' upriver of the array (Fig 1).

Smolt passing over the sonar gear register counts on the control units. Every 15 minutes counts are electronically totaled and recorded on paper tape. Counts are logged on a continuous 24-hour a day basis. Figure 2 shows the daily log with the steps for calculating the total daily outmigration. Adjustments for "false" counts caused by boats, rain, ice, wind, malfunctioning transducers, etc. are made which result in total adjusted counts (Step 1). These total adjustment counts are

multiplied by a velocity correction factor (Step 2) which is a linear adjustment of the counting rate relative to that of the center array. The center array in 1976 had an average water velocity reading of 5.2 feet per second (fps). The inshore array velocity of 4.5 fps. and the offshore velocity of 5.4 fps., when divided by the center array velocity, resulted in velocity correction factors of 0.87 and 1.04 respectively. No satisfactory technique for field calibration of the sonar has been developed thus far, so the theoretical 10 fish per count was used for the next expansion factor (Step 3).

An improved model of a narrow beam side-scanning sonar was tested on the Kvichak River this year and proved useful in describing the distribution, size, rate of travel and relative biomass of smolt schools passing down the river. This new version of the side-scanning type of sonar includes a multiple digital printout feature which permits a division of the sonified field into twelve equal sections. The unit then converts accumulated sonar echos from each individual segment into a numerical figure which is in turn recorded at regular intervals on printer paper. The unit helped determine that 100 ft of the channel was not used by the smolt (see Fig. 1). The 210 ft of channel remaining was divided into three sections, each centered on an array: inshore = 80 ft, center = 53 ft, and offshore = 77 ft. The river expansion factors (Step 4) were calculated by dividing each section by the 12 ft. coverage of the array. The three river expansion factors were: inshore = 6.7, center = 4.4, and offshore = 6.4.

Results

The peak of the Kvichak River smolt outmigration typically occurs prior to June 1. This year less than 2% of the season's total was accounted for by this date. The majority of the outmigration occurred during the 5 days immediately following termination of ice flows. The daily passage rate began picking up on June 8-9 and peaked two days later with a daily total of about 28 million smolt on June 10-11. After June 15 the daily outmigration dropped to around 1 million smolt or lower and continued at this rate until the sonar gear was removed from the river on June 18 (Table 4).

The total outmigration estimate for the period sampled was almost 103 million smolt of which approximately 100 million (97.2% of the total) were Age I smolt from the 1974 brood year of 4,4 million spawners (Table 5).

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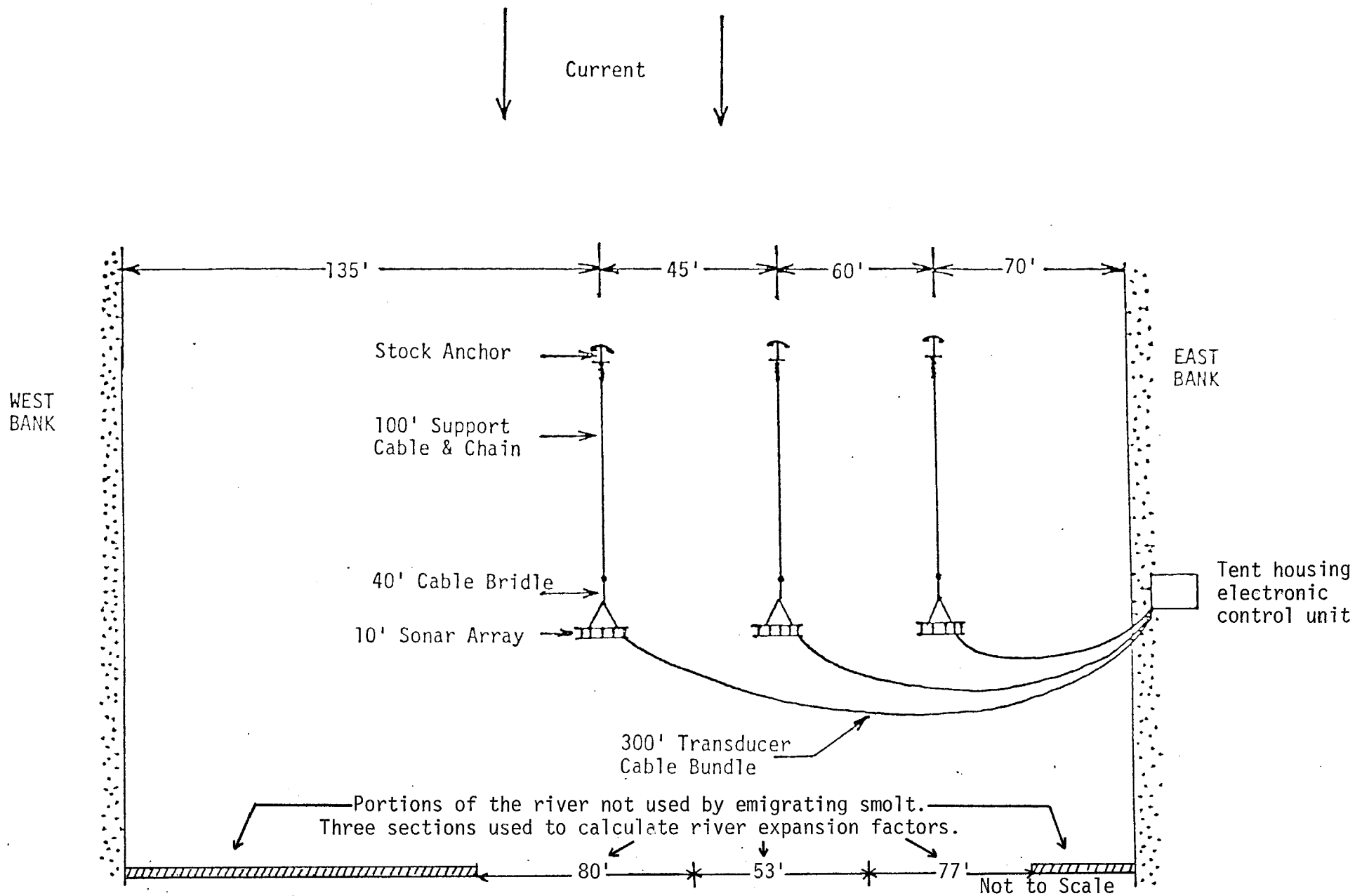
Figure 1.   Sonar equipment placement in the Kvichak River, 1976.

Figure 2. Sample of completed daily outmigration estimate.

BB-CF 506a

DAILY SONAR LOG

Day's Outmigration (I + C + O) = 2,244,565

Hour	Adj. Page	Disable Time (Sec.)	Inshore				Center				Offshore			
			Actual	Adj. Log	Missed Time	Final Adj.	Actual	Adj. Log	Missed Time	Final Adj.	Actual	Adj. Log	Missed Time	Final Adj.
13	78	633	1351	0	633	1650	1089	0	633	1330	2012	0	633	2457
14		0	679	0	0	679	831	0	0	831	1271	0	0	1271
15		0	258	0	0	258	883	0	0	883	782	0	0	782
16		65	286	0	65	291	726	3	65	747	1098	19	65	1099
17	79	0	551	0	0	551	1336	0	0	1336	360	0	0	360
18	1	546	270	0	546	320	784	21	546	904	1257	113	546	1356
19		0	303	0	0	303	959	0	0	959	809	0	0	809
20		159	567	0	159	594	355	0	159	373	758	0	159	796
21		0	633	0	0	633	1611	0	0	1611	573	0	0	573
22		0	185	0	0	185	1039	0	0	1039	608	0	0	608
23		0	98	0	0	98	700	0	0	700	130	0	0	130
24		0	278	0	0	272	2531	0	0	2531	484	0	0	484
1		539	2207	0	539	2704	1822	0	539	2154	159	0	539	188
2		0	241	0	0	241	332	0	0	332	100	0	0	100
3		0	12	0	0	12	239	0	0	239	166	0	0	166
4		0	21	0	0	21	141	0	0	141	60	0	0	60
5		0	44	0	0	44	204	0	0	204	104	0	0	104
6		0	100	0	0	100	253	0	0	253	237	0	0	237
7		0	76	0	0	76	141	0	0	141	228	0	0	228
8		0	41	0	0	41	202	0	0	202	116	0	0	116
9		376	9	0	376	10	254	0	376	285	474	0	376	554
10		0	254	0	0	254	221	0	0	221	321	0	0	321
11		0	153	0	0	153	260	0	0	260	175	0	0	175
12	79	0	12	0	0	12	307	0	0	307	534	0	0	534

Total (i) = 9,508   Total (c) = 17,983   Total (o) = 13503

Outmigration: Total adjusted counts x velocity correction x fish/count x   river expansion = total

Inshore (I) :   9508   .87   10   6.7   =   554 221
Center (C) :   Step 1. ————   Step 2. ————   Step 3. ——   Step 4. ——   = ————
                         17923   1.00   10   4.4   791.252

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Table 1. Climatological and stream observations, Kvichak River, May 18 - June 19, 1976.

Date	Sky 0800	Sky 2000	Wind Direction-Velocity (MPH) 0800	Wind Direction-Velocity (MPH) 2000	Air Temp. °C Max.	Air Temp. °C Min.	Water Temp. °C Max.	Water Temp. °C Min.	Precipitation (inches) 24 hrs.	Water Level 1/ (ft.) 0800	Turbidity 0800
5/18	-	3		N10	-	7	-	2.5	0	-	1
19	4	4	NE5	E5	13	2	2.0	2.0	T	-	1
20	2	2	calm	E5	24	1	2.5	2.0	0	-	2
21	5	2	N5	SW10	20	2	2.0	2.0	0	-	1
22	1	2	NE5	NE5	15	0	2.0	2.0	0	-	1
23	3	2	N5	calm	16	0	2.0	2.0	0	.30	1
24	4	4	S15	N5	7	1	2.5	2.0	.28	.32	2
25	4	3	S5	NW5	10	0	2.0	2.0	.06	.33	1
26	3	2	NW5	W5	7	-1	2.5	2.0	0	.35	1
27	3	3	W5	W5	7	-2	2.0	2.0	0	.42	1
28	2	4	NW10	NW5	7	2	2.5	2.0	0	.39	1
29	1	1	NW5	W5	14	5	2.5	2.5	0	.41	1
30	3	2	W5	SW5	15	0	3.0	2.5	0	.43	1
31	3	1	SW10	W5	14	2	3.0	3.0	0	.40	1
6/1	2	4	SW5	NE5	19	7	3.0	2.0	0	.43	1
2	4	4	SW5	S5	15	7	4.0	3.0	.04	.45	2
3	4	4	SW10	SE5	13	6	4.0	3.0	.02	.46	2
4	4	4	NE10	NE5	12	6	3.5	-	.40	.46	3
5	4	4	NE5	SE5	9	7	3.0	2.5	.33	-	6
6	4	4	SW5	SW10	12	10	2.5	2.0	.17	-	6
7	3	1	SW5	SW5	18	6	2.0	2.0	0	-	6
8	4	2	SW15	SW10	18	4	3.0	2.0	.02	-	6
9	4	3	SW5	SW10	14	4	4.0	3.0	0	-	2
10	3	2	NE10	NE5	24	6	5.0	4.0	.01	.73	2
11	1	3	SE5	calm	29	6	6.0	6.0	.01	.74	1

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Table 1. (continued)

Date	Sky 0800	Sky 2000	Wind Direction-Velocity (MPH) 0800	Wind Direction-Velocity (MPH) 2000	Air Temp. °C Max.	Air Temp. °C Min.	Water Temp. °C Max.	Water Temp. °C Min.	Precipitation (inches) 24 hrs.	Water Level 1/ (ft.) 0800	Turbidity 0800
12	1	2	SE5	NE5	24	7	7.0	6.0	T	.76	2
13	2	4	NE10	NE5	20	4	7.0	7.0	T	.77	2
14	4	4	NE5	NE5	17	7	7.0	7.0	.01	.81	2
15	3	3	NE5	NE5	16	7	7.5	7.0	.04	.88	2
16	4	4	NE10	NE5	16	6	7.5	7.0	.02	.90	2
17	4	4	NE5	SE10	15	6	7.5	7.5	.08	.89	2
18	4	4	SE10	SW5	13	5	7.0	7.0	.01	.90	2
19	3	1	SW5	NW5	20	7	9.5	7.0	0	-	1

1/ Denotes water level above that of base level set on 5/21/75.

Sky codes: 1- clear sky, cloud covering not more than 1/10.

2- cloud covering not more than 1/2.

3- cloud covering more than 1/2 of sky.

4- complete overcast.

5- fog.

Turbidity: 1- clear

2- light turbidity

3- medium turbidity

6- ice covered

Table 2   Kvichak River sockeye salmon smolt 24-hour index by day and age group, 1976.

| Date | Age I Smolt | | Age II Smolt | | 24-Hour Index | |
(1200-1200)	Number	Percent	Number	Percent	Number	Percent 1/
5/21-22	57	82	12	18	69	.01
22-23	0		0		0	
23-24	20	82	4	18	24	+
24-25	0		0		0	
25-26	0		0		0	
26-27	0		0		0	
27-28	0		0		0	
28-29	0		0		0	
29-30	7	100	0	0	7	+
30-31	0		0		0	
5/31-6/1	0		0		0	
1-2	95	99	1	1	96	.01
2-3	202	99	2	1	204	.03
3-4	41	99	0	1	41	.01
4-5	6,418	99	65	1	(6,483) 2/	.83
5-6	12,796	99	129	1	(12,925) 2/	1.65
6-7	18,205	94	1,162	6	(19,367) 2/	2.46
7-8	24,260	94	1,549	6	(25,809) 2/	3.28
8-9	30,316	94	1,935	6	(32,251) 2/	4.10
9-10	36,370	94	2,321	6	38,691	4.92
10-11	113,459	94	7,242	6	120,701	15.36
11-12	53,216	100	0	0	53,216	6.77
12-13	97,944	100	0	0	97,944	12.46
13-14	318,151	100	0	0	318,151	40.48
14-15	34,670	100	0	0	34,670	4.41
15-16	13,645	100	0	0	13,645	1.74
16-17	11,467	99	116	1	11,583	1.48
Total	771,339	98	14,538	2	785,877	100.0

1/ Percent daily catch is of season total
2/ Interpolated catches. No fishing due to ice.

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Table 3. Sonar aperture counter calibrations, Kvichak River, 1976.

Date	Sonar counts	Weight of catch (lb)	Fish per pound	Total catch	Elapsed time (min)	Rate (fish/min)	Fish per count
6/9	188	-	-	1,072	38	28	5.7
6/9	568	-	-	3,238	21	154	5.7
6/9	12	-	-	68	16	4	5.7
6/10	625	60	52	3,125	54	58	5.0
6/11	16	0	-	79	10	8	4.9
6/11	49	-	-	262	2	131	5.3
6/12	383	24	80	1,920	9	213	5.0
6/12	331	25	83	2,075	3	692	6.3
6/13	117	10	84	840	8	105	7.2
6/13	114	7	83	581	3	194	5.1

Table 4. Kvichak River daily sockeye salmon smolt counts by array, 1976. 1/

Date (1200-1200	Inshore Array	Center Array	Offshore Array	Total
5/22-23 2/	9,443	12,980	20,634	43,057
23-24	4,721	21,164	16,108	41,993
24-25	97,752	90,596	65,562	253,910
25-26	8,860	40,084	38,272	87,216
26-27	11,949	53,152	26,824	91,925
27-28	57,066	50,952	83,133	191,151
28-29	22,442	41,888	27,889	92,219
29-30	8,452	48,400	36,941	93,793
30-31	17,254	73,832	47,391	138,477
5/31-6/1	77,642	121,396	55,578	254,616
1-2	35,907	89,100	60,902	185,909
2-3	32,584	102,124	69,555	204,263
3-4	34,275	148,412	64,829	247,516
4-5	32,759	309,232	122,936	464,927
5-6	124,708	160,291	47,555	332,554
6-7	135,991	59,796	4,393	200,180
7-8	184,371	136,004	277,888	598,263
8-9	503,626	1,636,052	1,015,905	3,155,583
9-10	3,362,808	6,664,812	4,691,282	14,718,902
10-11	10,303,340	9,034,432	8,585,974	27,923,746
11-12	4,897,293	5,091,944	4,190,618	14,179,855
12-13	5,292,615	5,288,932	8,156,928	18,738,475
13-14	1,926,426	6,841,560	6,171,310	14,939,296
14-15	554,221	791,252	899,092	2,244,565
15-16	132,610	330,176	493,476	956,262
16-17	205,589	573,980	753,126	1,532,695
17-18	180,582	352,396	373,601	906,579
Total	28,255,286	38,164,939	36,397,702	102,817,927
Percent of Total	27.5%	37.1%	35.4%	

1/ Counts include interpolations for missed time, expansions for unsonified areas between arrays and adjustments for water velocity differences.

2/ Counts from 2100 hrs, May 22 thru 1200, May 23.

Table 5. Kvichak River sockeye salmon smolt outmigration by day and age class, 1976.

Date (1200-1200)	Age I Smolt Number	Age I Smolt Percent	Age II Smolt Number	Age II Smolt Percent	Total Outmigration Number	Total Outmigration Percent
5/22-23 1/	35,307	82	7,750	18	43,057	.04
23-24	34,434	82	7,559	18	41,993	.04
24-25	208,206	82	45,704	18	253,910	.25
25-26	71,517	82	15,699	18	87,216	.09
26-27	75,379	82	16,546	18	91,925	.09
27-28	191,151	100	0	0	191,151	.19
28-29	92,219	100	0	0	92,219	.09
29-30	93,793	100	0	0	93,793	.09
30-31	138,477	100	0	0	138,477	.13
5/31-6/1	254,616	100	0	0	254,616	.25
1-2	184,050	99	1,859	1	185,909	.18
2-3	202,220	99	2,043	1	204,263	.20
3-4	245,041	99	2,475	1	247,516	.24
4-5	460,278	99	4,649	1	464,927	.45
5-6	329,228	99	3,326	1	332,554	.32
6-7	188,169	94	12,011	6	200,180	.19
7-8	562,367	94	35,896	6	598,263	.58
8-9	2,966,248	94	189,335	6	3,155,583	3.07
9-10	13,835,768	94	883,134	6	14,718,902	14.32
10-11	26,248,321	94	1,675,425	6	27,923,746	27.16
11-12	14,179,855	100	0	0	14,179,855	13.79
12-13	18,738,475	100	0	0	18,738,475	18.23
13-14	14,939,296	100	0	0	14,939,296	14.53
14-15	2,244,565	100	0	0	2,244,565	2.18
15-16	956,262	100	0	0	956,262	.93
16-17	1,517,368	99	15,327	1	1,532,695	1.49
17-18	897,513	99	9,066	1	906,579	.88
Total	99,890,123	97	2,927,804	3	102,817,927	100.00

1/ From 2100 May 22 until 1200 May 23.

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1976 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

This was the twenty-first year that the Naknek River sockeye salmon, (Oncorhynchus nerka) smolt study has been conducted. The objective of the program is to obtain an estimate of the age composition and number of out-migrating smolt to be used as an aid in forecasting adult returns and defining optimum escapements. The project was initiated by the U.S. Fish and Wildlife Service in 1956 and transferred to the Alaska Department of Fish and Game in 1966. The study has remained relatively unchanged during the entire period.

MATERIALS AND METHODS

Standard fyke nets 4 feet wide and 4 to 7 feet deep were fished during the 1976 season. The nets were suspended from a cable stretched across the river bottom at a location approximately 8-3/4 miles below the outlet of Naknek Lake. Live boxes were used during both the random and index schedules to minimize smolt mortality (McCurdy, 1972).

In 1957 and 1958, the entire river was sampled to determine the most productive sites. Data obtained from this effort indicated that 88% of the entire outmigration passed within the six sites now used. The most productive individual site (no. 4) was used as an index site (McCurdy, 1969).

The basic fishing schedule based for the latin square scheme is 3 days long. The first day, all six sites are fished for 1-1/2 hours each in a random schedule from 2100 to 0600 hours. The second day the random schedule is again fished in addition to the index site which is fished continually for 24 hours. There is no fishing the third day.

A total of 569 smolt samples was collected from the random and index sites to determine age and lengths and 227 were sampled for weight. The sampling schedule was changed for the 1976 season by dividing the outmigration period into 9-day segments and obtaining 300 samples for each segment. Sampling hours were chosen in a random manner using only those hours when fyke nets were actually fishing either the random or index schedule. Because not enough samples were being obtained for each 9-day segment using the random schedule, the schedule used in all previous years was put back into effect on June 12. This schedule consisted of collecting 20 samples after midnight on each night fished.

RESULTS

Climatological and Hydrological Data

Table 1 contains the mean water and air temperatures during the 1976 field season. Peak outmigration occurred on June 4-5 when the average water temperature first exceeded 10°C.

During the first 3 weeks of operation the water level was extremely low. The total rise in water depth from initiation to termination of the project was 6.4 feet.

Age, Weight, and Length Data

Results of age determination indicate that 38.8% (330,312) of the out-migration during the study period was composed of Age I smolt, 60.3% (1,290,408) Age II smolt, and 0.9% (19,260) Age III smolt (Table 2).

Age I smolt averaged 7.2 grams, Age II smolt averaged 13.4 grams and Age III smolt averaged 22.2 grams (Table 3). The average weight of Age I smolt is the second lowest in the project's history. The average weight of Age II smolt was slightly above average.

Average length was 91 mm for Age I smolt, 107 mm for Age II smolt, and 131 mm for Age III smolt (Table 4). Average lengths for both Age I and Age II smolt were much lower than the historical average.

Random Catch

The random fishing scheme began on May 22 and ended on June 26. During this period a total of 33,216 smolt were captured. Nearly half of this catch was obtained at the index site (site 4). The major peak day was on June 4-5 when 11,227 smolt or 33.8% of the total catch, were trapped. A second smaller peak occurred on June 13-14 when 4,787 smolt, or 17.4% of the total catch, were trapped. Table 5 contains the results of the random fishing schedule.

The total outmigration estimate for the period sampled in 1976 is 2,139,890 smolt. This estimate was calculated by expanding the average 90 minute catch per sampling site. The total random catch for the season is used to determine the average 90 minute catch (VanValin, 1969).

Index Catch

Table 6 contains the results of the index fishing scheme. The total catch made during the index fishing scheme was 44,282 smolt. Peak catches were made on June 4-5 and June 13-14. A total of 95.1% of the smolt out-migrated during the random fishing hours of 2100-0600.

Editor's Note:

This year (1976) will be the last year that the Naknek River sockeye salmon smolt studies will be operated as a fyke net project. Beginning in 1977, a smolt enumeration project using sonar will be initiated on the Naknek River. It is anticipated that the smolt outmigration estimates developed from the sonar project will be more accurate and consistent than former estimates. The former estimates are believed to be invalid because, when related to appropriate adult returns, they result in unrealistically high marine survival figures. Since the primary purpose of salmon out-migration enumeration programs is to aid in forecasting adult returns, it is important to upgrade old programs and use the latest techniques to provide the most reliable information possible.

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Table 1. Mean water and air temperatures by date, Naknek River, 1976.[1]

Date	Mean Water Temperature °C	Mean Air Temperature °C
May 22-23	7.7	1.9
23-24	6.8	4.6
25-26	4.6	0.6
26-27	5.0	-0.8
28-29	5.9	2.8
29-30	6.7	-0.3
31-June 1	7.8	4.8
1-2	8.1	6.8
3-4	9.7	6.0
4-5	10.2	10.1
6-7	9.4	4.5
7-8	10.8	4.6
9-10	8.4	7.3
10-11	9.6	5.4
12-13	11.5	5.8
13-14	10.8	7.9
15-16	11.8	7.8
16-17	11.9	7.8
18-19	10.8	6.7
19-20	12.1	5.6
21-22	12.8	5.7
22-23	11.7	7.8
24-25	11.6	4.4
25-26	12.3	4.6

[1] Both water and air temperatures were recorded for each 90-minute fishing period during random hours.

Table 2. Estimated smolt outmigration by age class and sample period, Naknek River, 1976.

Date	Age I		Age II		Age III		Total
	Number	%	Number	%	Number	%	
May 22-May 30	3,321	72.0	1,290	28.0	0	0.0	4,611
May 31-June 8	350,392	28.5	859,412	70.0	19,260	1.5	1,229,064
June 9-June 17	357,034	48.4	379,380	51.6	0	0.0	736,414
June 18-June 26	119,565	70.4	50,326	29.6	0	0.0	169,891
TOTALS	830,312	38.8	1,290,408	60.3	19,260	9.0	2,139,980

n = 569

Table 3. Sample size, mean weight (in grams), and variance for sockeye salmon smolt by age class and sample period, Naknek River, 1976.

Period	Age I			Age II			Age III		
	n	$\overline{x}$	s^2	n	$\overline{x}$	s^2	n	$\overline{x}$	s^2
May 22-May 30	11	4.6	0.86	6	9.4	8.12	0	0.0	0.00
May 31-June 8	12	8.6	2.07	70	15.9	6.76	2	22.2	8.76
June 9-June 17	33	7.1	1.46	32	10.7	11.97	0	0.0	0.00
June 18-June 26	41	7.7	4.34	20	10.1	17.64	0	0.0	0.00
Totals	97	7.2	0.04	128	13.4	0.07	2	22.2	0.00

Table 4. Sample size, mean length (in millimeters) and variance of sockeye salmon smolt by age class and sample period, Naknek River, 1976.

Period	Age I			Age II			Age III		
	n	$\overline{x}$	s^2	n	$\overline{x}$	s^2	n	$\overline{x}$	s^2
May 22-May 30	11	76.0	24.20	6	101.7	73.78	0		
May 31-June 8	35	93.2	35.40	86	114.3	83.90	2	131.0	17.97
June 9-June 17	97	90.2	35.40	103	104.7	132.71	0		
June 18-June 26	162	92.6	57.00	67	101.9	129.50	0		
Totals	569	91.3	0.28	262	107.1	0.55	2	131.0	17.97

Table 5. Random catches of sockeye salmon smolt by fishing site, Naknek River, 1976.

Date	Sites						Total	Percentage of Total Catch
	1	2	3	4	5	6		
May 22-23	1	0	0	2	4	1	8	0.02
23-24	0	1	2	0	0	2	5	0.02
25-26	0	3	18	10	10	0	41	0.12
26-27	0	0	0	0	1	0	1	0.00
28-29	0	0	2	0	0	1	3	0.01
29-30	0	0	10	0	0	2	12	0.03
31-June 1	0	0	6	1	0	0	7	0.02
1-2	11	0	3	0	0	23	37	0.11
3-4	66	60	0	1	0	1	128	0.39
4-5	0	0	888	9,339	999	1	11,227	33.80
6-7	13	690	2,800	172	270	0	3,945	11.88
7-8	0	0	270	40	3,188	252	3,750	11.29
9-10	0	462	0	826	752	288	2,328	7.01
10-11	68	0	11	430	1	0	510	1.54
12-13	2	300	0	583	47	0	932	2.81
13-14	1,092	449	1,296	2,668	0	282	5,787	17.42
15-16	0	2	1,104	1	1	78	1,186	3.57
16-17	0	0	135	0	133	417	685	2.06
18-19	240	1	116	6	420	1	784	2.36
19-20	9	0	200	0	5	4	218	0.66
21-22	0	0	9	0	69	1	79	0.24
22-23	0	2	2	348	0	208	560	1.68
24-25	1	58	1	145	2	39	246	0.74
25-26	0	20	0	715	0	2	737	2.22
Total	1,503	2,048	6,873	15,287	5,902	1,603	33,216	
Percent	4.52	6.17	20.69	46.02	17.77	4.83	100.0	100.00

Table 6. Index net catches of sockeye salmon smolt by 90-minute periods, May 23-June 26, Naknek River, 1976.

Time	May 23-24	May 26-27	May 29-30	June 1-2	June 4-5	June 7-8	June 10-11	June 13-14	June 16-17	June 19-20	June 22-23	June 25-26	Total	% of Total Catch
2100-2230	0	0	0	0	950	273	2	846	64	0	0	37	2,172	4.90
2230-2400	11	3	0	240	2,768	3,772	328	2,668	204	85	348	318	10,745	24.27
0000-0130	4	3	11	371	9,339	4,338	430	3,456	1,372	147	2,080	715	22,266	50.28
0130-0300	1	0	7	3	1,548	40	36	600	1,442	9	408	255	4,349	9.82
0300-0430	1	0	0	0	68	0	2	400	448	0	0	0	919	2.08
0430-0600	0	2	0	0	0	563	14	878	0	0	102	3	1,562	3.53
0600-0730	0	0	0	0	0	37	1	12	0	4	37	0	91	0.21
0730-0900	0	0	2	0	26	192	3	87	0	1	0	0	311	0.70
0900-1030	0	0	1	0	5	104	0	448	0	0	0	0	558	1.26
1030-1200	0	1	0	0	8	67	0	2	37	0	0	0	115	0.26
1200-1330	0	0	0	0	11	0	0	0	44	0	0	0	55	0.12
1330-1500	0	0	1	0	8	0	0	150	22	0	0	0	181	0.41
1500-1630	0	0	0	0	2	0	0	0	0	2	0	0	4	0.01
1630-1800	0	0	0	0	14	0	0	354	28	0	0	0	396	0.89
1800-1930	0	0	0	0	27	0	0	212	0	0	0	0	239	0.54
1930-2100	0	0	0	0	120	0	0	4	174	18	0	3	319	0.72
Totals	17	9	22	614	14,894	9,386	816	10,117	3,835	266	2,975	1,331	44,282	100.00

1976 WOOD RIVER SOCKEYE SALMON SMOLT STUDIES

By

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INTRODUCTION

The Wood River smolt project was initiated in 1951 to obtain
an abundance index of the annual sockeye salmon smolt outmigration.
The project was not operated in 1968, 1971, and 1972. In 1967, 1969,
and 1970, it was operated in conjunction with the Bureau of Commercial
Fisheries Smolt Marking Program. The index project was terminated
in 1972 because the relationship between the outmigration index and
the eventual returns of adult sockeye salmon was found to be extremely
variable and, therefore, of little value in forcasting the magnitude
of future runs.

In 1975, $600,000 was appropriated by the Alaska Legislature to
investigate rehabilitation opportunities for the sockeye salmon runs to
the Wood River Lakes. To adequately evaluate the management options
based on the results of the component projects, it was deemed necessary
to determine a total outmigration estimate of smolt migrating from the
Wood River system.

The results of 1975 studies indicated that smolt distribution at
the Wood River sonar site is not random. The inshore array (array I),
located 50 feet from the north bank, consistently enumerated more smolt
than the offshore array (array II) located 110 feet from the shore.
Additionally, information derived from both the side-scanning sonar and
the bottom sonar arrays demonstrated a marked shift of the predominate
migration path; inshore during late evening, and offshore in the early
morning. Apparently the arrays, although sampling less than 10% of the
river volume, enumerated far more than 10% of the total outmigration.
Because of the inability to estimate the proportion of the smolt enumerated
by the arrays, the sonar count data could not be expanded to estimate
total smolt passage (Krasnowski 1976). This project was continued in
1976 with the specific objectives of estimating the number, age composition
and size of the smolt emigrating from the Wood River system.

METHODS AND MATERIALS

The components and operation of the Wood River smolt sonar system
are described by Krasnowski (1976). Two additional arrays were added
to the sonar system in 1976, to better estimate smolt distribution
across the river. Arrays I and II were placed in the same position as
in 1975. Arrays III and IV were positioned 160 feet and 200 feet,
respectively, from the north bank and generally in line with arrays I
and II.

Manpower limitations prevented operation of the sonar gear on a 24-hour per day basis. During each 5-day sample period (120 hours) the sonar was operated for 75 hours. Each sample period was divided into 3-hour blocks. The sonar gear was operated each night from 9:00 pm to 3:00 am (10 3-hour blocks per sample period) because the majority of the 1975 counts had occurred during this interval. The remaining 15 3-hour blocks of sample time were selected randomly with the probability of selecting a block between 3:00 pm to 9:00 pm or 3:00 am to 9:00 am twice the probability of selecting an interval between 9:00 am and 3:00 pm.

Since the majority of the counts in 1975 had been enumerated by array I, it was operated whenever the sonar gear was operational. Arrays II, III, and IV were operated in random sequence for 15 minute intervals within each 3-hour time block. Counts recorded for arrays II, III, and IV were expanded for time not operational, yielding hourly estimates of counts for each array. Total hourly counts for hours not sampled were estimated by linear interpolation.

Since the river at the sonar site is subject to tidal influence, river velocity fluctuates continually with the ebb and flood. The difference between actual river velocity and the 4.5 feet per second velocity set on the electronics causes the electronics to undercount or overcount in direct proportion to the ratio of the velocity set on the electronics to the actual river velocity. In order to develop a statistical velocity model to estimate hourly velocities and correct all hourly counts, lake depths were recorded at the ADF&G cabin at Lake Aleknagik six times daily and river depth was recorded every 15 minutes at the sonar site. Over the course of the season, 82 river velocity measurements were made at a depth of 12 inches behind array I using a pygmy Gurley meter. Additionally, velocity measurements were made sequentially behind the four arrays on 22 occasions to determine the river velocities at each array relative to those of array I.

Raw count data expanded for the times not counted, were corrected for hourly river velocity changes and expanded for the theoretical five fish per count rate (Krasnowski, 1976). Since each array sonified an 11 foot section of the river, hourly counts for each array were divided by 11 to convert the data to fish density (passage per foot). Assuming zero fish passage at the banks, this density at the mid-point of each array, was used to construct a series of triangles and trapezoids (Figure 1). The sum of their areas was used as an hourly estimate of total outmigration across the river.

Smolt were collected for age-weight-length analysis with a beach seine, near the outlet of Lake Aleknagik. Five samples of approximately 60 smolt each were collected during each sample period. Times for sampling were selected randomly with probabilities roughly proportional to the magnitude of the outmigration during those hours last year. However, because it was difficult to obtain enough fish during the selected hours, the random sampling scheme was abandoned on June 14-15 and the 60 fish were collected at 0100 every night. Each smolt was measured for fork length and gross external observations were made for signs of parasitism by _Triaenophorous crassus_. Means and variances of lengths were calculated using formulae for stratified samples with unequal sample sizes. Mean weights for each age group were to be calculated on the basis of a length-weight regression ($W=al^b$), and a correction factor to obtain an unbiased estimate of mean weight (Pienaar and Richer, 1968).

Hydrology

Stream temperatures were recorded at the sonar site at midnight each sample day. Temperatures are listed in Table 1 and plotted in Figure 2.

The river velocity model developed to correct the 1975 data (Krasnowski 1976) was modified slightly to simplify the correction of the 1976 smolt counts. Two components of river depth effect the velocity of the river; fluctuations in lake level and tide stage. The model requires an estimate of daily mean water depth at the sonar site, i.e. an estimate of daily depth which avoids tidal influence. The river fluctuates several feet from ebb to flood whereas the lake at the ADF&G cabin fluctuates only inches. Lake depth was measured six times daily and the daily mean lake depths taken over the course of the season were fitted to the following equation using least squares techniques:

$$\hat{D}_L = 0.516 + 0.274\ X_1 - 0.009\ X_1^2 + 0.00008\ X_1^3 \qquad [1]$$

where $\hat{D}_L$ = daily mean depth of the lake measured at the cabin

X_1 = time in days using June 3, 1976 = day 1

Although river depth fluctuates more widely than lake depth, there is a significant linear relationship between daily mean depths of the river and the lake:

$$\hat{D}_R = 6.752 + 0.828\ X_2 \qquad [2]$$

$$r = 0.953 \quad n = 60 \quad p < 0.001$$

$$r^2 = .909 \quad s_{y \cdot x} = 0.214$$

where $\hat{D}_R$ = daily mean river depth

X_2 = daily mean lake depth

By substituting, equation [1] for X_2 in equation [2], an estimate of daily mean river depth ($\hat{D}_R$) can be made, essentially ignoring tidal influences, as a function of time in days:

$$\hat{D}_R = 7.180 + 0.227\ X_1 - 0.0077\ X_1^2 + 0.00007\ X_1^3$$

where X_1 = time in days, and June 3 = day 1

In analyzing the 1975 data, a regression was calculated which related the velocity measurements to the daily mean depth of the river ($\hat{D}_R$) and the tide stage published for Clark's Point 2 hours prior. This tide time lag was estimated from depth fluctuations at the sonar site; they were, however, quite variable. To avoid this problem, the 1976 velocity data were fitted to a multiple regression with $\hat{D}_R$ as one dependent variable and the difference between $\hat{D}_R$ and the depth above array I as a second dependent variable:

$$\hat{V}_I = 0.403 + 2.480 \, [\hat{D}_R - D_I] + 0.548 \, [\hat{D}_R]$$

$$r = 0.835 \quad p < 0.001$$

$$F = 109.48 \quad df = 2,95$$

where $\hat{V}_I$ = velocity measured over array I

$\hat{D}_I$ = depth measured over array I

Sonar Enumeration

The four sonar arrays were installed in the river on May 30. The counter was operated intermittently through June 9 when the counts became frequent enough to begin the sonar sampling schedule. Counting was terminated on August 8 and the gear was removed from the water. Table 2 lists the corrected counts by array by day for the 1976 season. Of the corrected total of 2,395,175 counts, 49% were recorded by array I, 30.2% by array II, 11.7% by array III and 9.1% by array IV. Daily outmigration estimates are shown in Figure 3. The daily outmigration estimates based on these counts and the expansion techniques described above were grouped into the five-day sample periods and the age composition estimates derived from the beach seine samplings were applied. Table 3 lists the estimated outmigration by sample period and age group. Mean lengths by sample period are shown in Table 4. Weighted mean lengths were 83.5 mm for Age I and 94.9 mm for Age II smolt.

Because of an oversight in the age-weight-length sampling, weights were measured only for the samples taken through June 12. Because the smolt sampled at Mosquito Point are from several distinct rearing basins, the results of the weight sampling are probably representative only of the earliest portion of the outmigration. Mean weight for age I smolt collected through June 12 was 3.5 grams. Because only 14 age II smolt were collected a weight length regression was not calculated. The sample mean weight for Age II smolt was 7.7 grams ($s_X = 1.40$).

Expansion of 1975 Data

As previously discussed, the 1975 sonar count data were based on two arrays (I and II) and were not sufficient to estimate smolt outmigration across the river. The 1976 data were examined to determine the relationship of the counts recorded by arrays I and II to the outmigration estimate for the same time period based on all four arrays. The resultant least squares linear regression is listed below:

$$\hat{Y} = 28,055.31 + 6.31 \, X$$

$$r = .969 \quad n = 60 \quad p < 0.001$$

where $\hat{Y}$ = daily outmigration estimate

X = total counts for array I + II

The total daily counts for the 1975 data were expanded to give an estimate of outmigration by day for the 1975 season. Age composition data were applied to give estimates of outmigration by age class. These data are summarized in Table 5. Table 6 summarizes the smolt outmigration data from 1975 and 1976. Table 7 shows smolt production by brood year. The 1973 brood year appears to have produced approximately 20.0 smolt per spawner. For comparison, the Kvichak River smolt program, operating with similar equipment has provided estimates of 18.2, 13.7 and 17.2 smolt per spawner for the brood years 1970, 1971 and 1972, respectively (ADF&G unpublished data).

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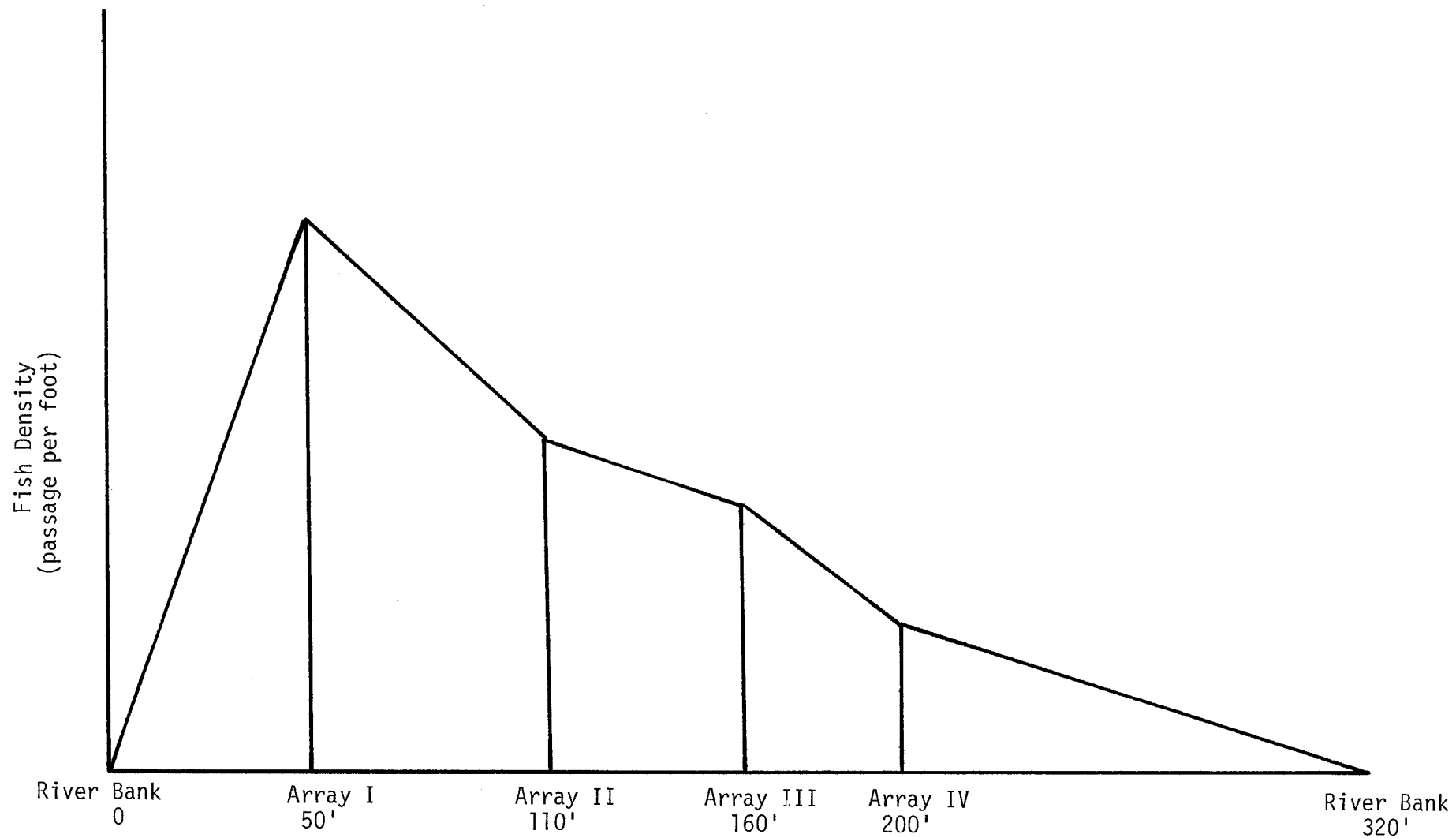length statistics. J. Fish. Res. Bd. Canada, 25(12): 27432747.

Figure 1. Diagram illustrating fish density v.s. distance across Wood River at the sonar site. The sum of the areas of the triangles and trapezoids is equal to the total outmigration for a given period of time.
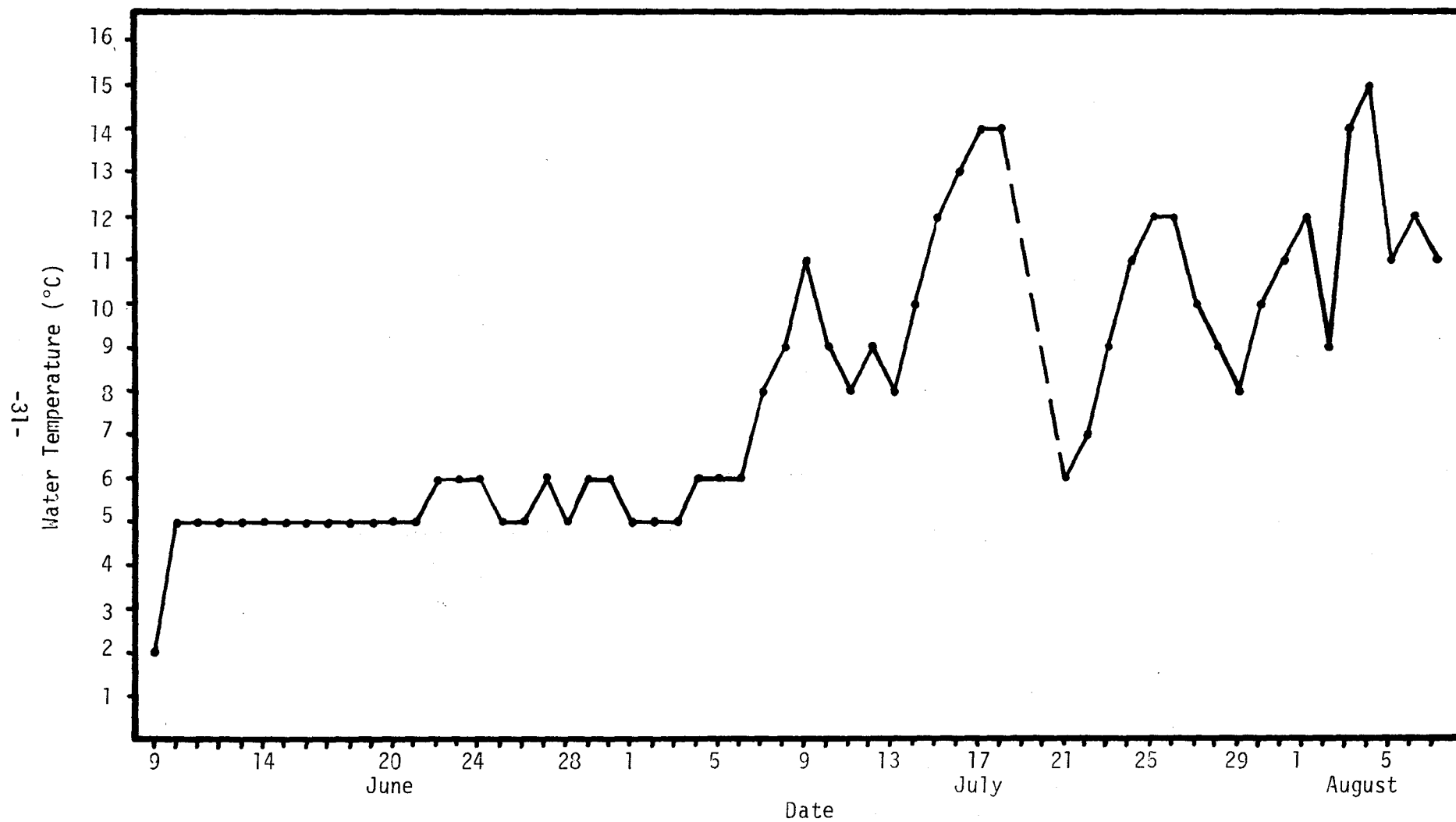
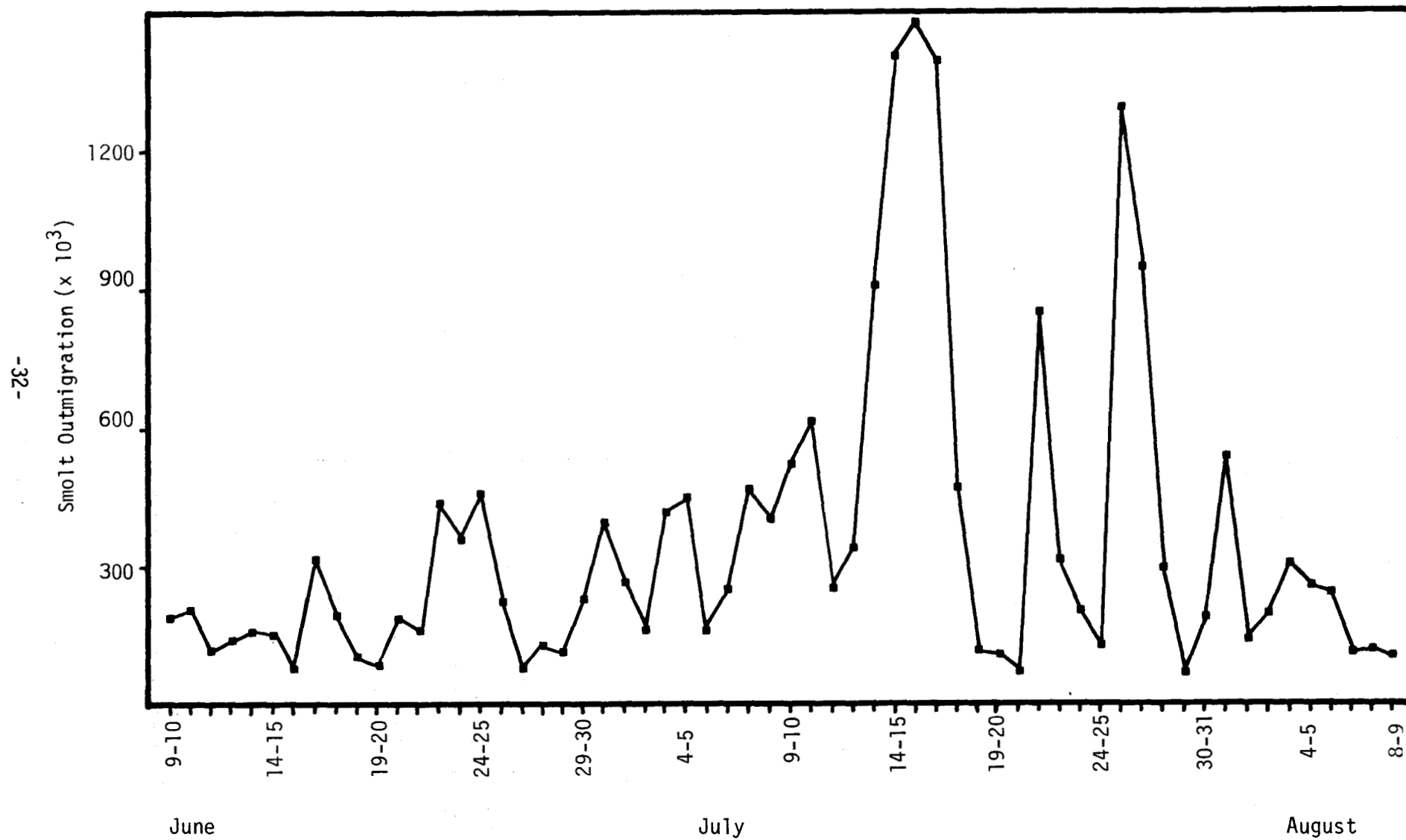Figure 2.   Stream temperatures recorded at Wood River sonar site, 1976.

Figure 3. Wood River smolt outmigration by date, 1976.

Table 1. Air temperature and water temperature recorded at sonar site, Wood River, 1976.

Date	Air Temperature (°C) Max.	Min.	Water Temperature (°C)	Date	Air Temperature (°C) Max.	Min.	Water Temperature (°C)	Date	Air Temperature (°C) Max.	Min.	Water Temperature (°C)
6/9	26	-1	2	7/1	17	9	5	7/23	19	11	9
10	26	2	5	2	13	6	5	24	19	10	11
11	29	7	5	3	26	6	5	25	21	4	12
12	28	6	5	4	14	6	6	26	21	6	12
13	23	4	5	5	18	3	6	27	17	6	10
14	15	6	5	6	19	7	6	28	17	10	9
15	12	6	5	7	27	5	8	29	14	7	8
16	11	4	5	8	24	7	9	30	15	4	10
17	13	1	5	9	27	8	11	31	19	10	11
18	11	3	5	10	26	8	9	8/1	18	8	12
19	15	3	5	11	14	7	8	2	21	7	9
20	21	0	5	12	18	9	9	3	25	9	14
21	18	4	5	13	20	7	8	4	23	10	15
22	23	7	6	14	23	6	10	5	29	11	11
23	24	4	6	15	23	4	12	6	21	10	12
24	26	7	6	16	29	11	13	7	17	14	11
25	17	4	5	17	28	10	14				
26	22	4	5	18	28	12	14				
27	21	4	6	19	21	11	-				
28	6	4	5	20	16	9	-				
29	26	4	6	21	11	7	6				
30	24	7	6	22	18	11	7				

Table 2. Sonar counts by array, Wood River, 1976.

Date		Array Number I	II	III	IV	Total Counts
June	9-10	5,255	3,396	2,194	1,416	12,261
	10-11	13,152	5,876	1,335	911	21,274
	11-12	4,024	8,081	1,989	3,088	17,182
	12-13	7,346	9,766	2,488	1,260	20,860
	13-14	1,181	5,406	928	1,798	9,313
	14-15	15,722	8,071	1,053	935	25,781
	15-16	2,886	6,585	1,046	669	11,186
	16-17	18,838	2,999	1,048	1,493	24,378
	17-18	4,713	10,281	3,713	1,206	19,913
	18-19	2,218	4,946	2,121	1,242	10,527
	19-20	8,695	5,229	877	505	15,306
	20-21	15,465	12,216	2,836	2,345	32,862
	21-22	16,644	7,406	906	1,271	26,227
	22-23	20,346	18,088	7,654	3,434	49,522
	23-24	39,930	12,742	774	430	53,876
	24-25	36,524	24,680	1,643	1,331	64,178
	25-26	19,604	15,275	881	792	36,552
	26-27	8,096	3,548	1,114	783	13,541
	27-28	17,134	5,417	1,036	648	24,235
	28-29	12,195	3,190	411	96	15,892
	29-30	11,683	3,924	868	615	17,090
June	30-July 1	35,157	12,853	1,494	471	49,975
	1-2	10,434	27,102	7,869	3,955	49,360
	2-3	4,587	15,808	1,512	1,663	23,570
	3-4	6,215	26,496	15,414	5,877	54,002
	4-5	45,161	19,299	1,997	3,803	70,260
	5-6	5,990	5,269	3,819	2,053	17,131
	6-7	13,087	4,426	1,641	1,659	20,813
	7-8	22,876	16,992	4,467	3,609	47,944
	8-9	15,528	20,743	12,443	9,215	57,929
	9-10	24,045	17,182	9,702	6,117	57,046
	10-11	36,455	16,469	10,556	7,491	70,971
	11-12	4,719	8,958	10,100	14,518	38,295
	12-13	24,770	17,877	4,548	4,044	51,239
	13-14	56,773	15,211	6,180	3,253	81,417
	14-15	119,720	48,634	15,867	6,270	190,491
	15-16	135,729	66,619	30,803	9,619	242,770
	16-17	107,630	38,418	12,934	13,828	172,810
	17-18	14,112	18,507	9,495	11,234	53,348
	18-19	9,366	11,711	7,813	9,306	38,196

Continued

Table 2. Continued

| Date | Array Number | | | | Total Counts |
	I	II	III	IV	
19-20	1,425	506	1,725	261	3,917
20-21	5,029	1,854	3,620	1,300	11,803
21-22	68,814	12,381	3,650	4,860	89,705
22-23	5,772	7,293	8,795	2,331	24,191
23-24	5,223	4,829	3,719	3,686	17,457
24-25	5,224	4,531	2,681	4,153	16,589
25-26	7,405	5,055	6,166	8,223	26,849
26-27	5,696	8,074	2,224	3,193	19,187
27-28	11,612	5,477	2,345	2,636	22,070
28-29	3,661	3,456	2,009	1,475	10,601
29-30	5,819	4,528	2,661	2,771	15,779
30-31	12,606	11,348	6,902	10,128	40,984
July 31-August 1	3,801	3,726	2,540	2,918	12,985
1-2	5,554	6,048	3,190	2,592	17,384
2-3	15,487	15,198	5,407	2,469	38,561
3-4	12,636	17,556	6,977	5,516	42,685
4-5	14,498	14,891	4,524	6,093	40,006
5-6	4,119	2,795	2,559	2,529	12,002
6-7	3,341	3,774	1,705	3,222	12,042
7-8	3,057	3,371	2,175	2,252	10,855
Totals	1,174,784	722,387	281,143	216,861	2,395,175
	49.0%	30.2%	11.7%	9.1%	100.0%

Table   3.   Estimated smolt outmigration by age class and sample period,
Wood River, 1976.

Sample Period	Age I		Age II		
	No.	%	No.	%	Total
June 9-14	768,628	92.0	66,837	8.0	835,465
June 14-19	769,230	89.2	93,135	10.8	862,365
June 19-24	1,215,703	97.3	33,735	2.7	1,249,438
June 24-29	978,511	95.8	42,899	4.2	1,021,410
June 29-July 4	1,455,487	97.5	37,320	2.5	1,492,807
July 4-9	1,692,589	97.3	46,968	2.7	1,739,557
July 9-14	2,569,097	97.4	68,580	2.6	2,637,677
July 14-19	4,731,696	97.2	136,304	2.8	4,868,000
July 19-24	1,537,157	99.3	10,836	0.7	1,547,993
July 24-29	2,636,160	95.9	112,703	4.1	2,748,863
July 29-August 3	1,258,057	90.7	128,996	9.3	1,387,053
August 3-8	669,084	81.9	184,498	18.1	853,582
Total	20,281,399	95.5	962,811	4.5	21,244,210

Table 4. Sample size, mean lengths (in millimeters), and variance for Age I and Age II sockeye salmon smolt by sample period, Wood River, 1976.

Sample Period	Age I			Age II		
	n	$\bar{x}$	s^2	n	$\bar{x}$	s^2
June 9-14	150	76.8	36.0	13	104.3	16.8
June 14-19	74	80.4	26.0	9	100.0	19.4
June 19-24	72	82.9	12.3	2	98.5	.5
June 24-29	46	79.1	12.3	2	95.0	50.4
June 29-July 4	234	80.8	36.0	6	103.2	46.2
July 4-9	292	82.4	16.8	8	85.1	1142.4
July 9-14	147	81.5	77.4	4	102.3	106.1
July 14-19	241	84.7	16.0	7	89.6	1325.0
July 19-24	138	83.3	28.1	1	94.0	-
July 24-29	93	87.0	24.1	4	95.3	25.0
July 29-August 3	68	87.5	132.3	7	93.4	14.4
August 3-8	68	90.7	20.3	15	90.3	635.0
Total	1623	83.5	.03	78	94.9	13.9

Table 5. Smolt outmigration by age class and sample period, Wood River, 1975.

Sample Period	Age I		Age II		Total
	No.	%	No.	%	
June 12-18	1,205,961	99.0	12,181	1.0	1,218,142
June 18-23	643,112	94.2	59,597	5.8	682,709
June 23-28	752,260	85.0	132,752	15.0	885,012
June 28-July 3	707,323	81.6	159,494	18.4	866,817
July 3-July 8	1,002,201	76.0	316,485	24.0	1,318,686
July 8-20	1,280,296	71.2	517,872	28.8	1,798,168
Total	5,591,153	82.6	1,178,381	17.4	6,769,534

Table 6. Summary of the Wood River smolt outmigrations, 1975 and 1976 (number of fish x 10^6).

Year of Outmigration	Age I	Age II	Total
1975	5.59	1.18	6.77
1976	20.28	0.96	21.24

Table 7. Smolt production by brood year, Wood River (number of fish x 10^6).

Brood Year	Escapement	Age I	Age II	Total
1972	0.43	-	1.2	-
1973	0.33	5.6	1.0	6.6
1974	1.71	20.3	-	-